RL/REG-99-20
Revision 1

Review Guidance for the Revised Standards Approval Package For Construction Authorization

January 2000

Office of Safety Regulation of the TWRS-P Contractor

U.S. Department of Energy
Richland Operations Office
P.O. Box 550, A4-70
Richland, Washington 99352

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Approved: _____

Date: _____

PREFACE

The U.S. Department of Energy's (DOE) Richland Operations Office (RL) issued a request for proposal in February 1996 for privatized processing of waste as part of the Hanford Tank Waste Remediation System (TWRS) program which in 1999 came under the cognizance of the Office of River Protection (ORP). Offerors were requested to submit proposals for the initial processing of the tank waste at the Hanford Site. Some of this radioactive waste has been stored in large underground storage tanks at the Site since 1944. Currently, approximately 54 million gallons of waste containing approximately 250,000 metric tons of processed chemicals and 215 million curies of radionuclides are being stored in 177 tanks. These caustic wastes are in the form of liquids, slurries, saltcakes, and sludges. The wastes stored in the tanks are defined as high-level radioactive waste (10 CFR Part 50, Appendix F) and hazardous waste (Resource Conservation and Recovery Act).

Under the privatization concept, DOE intends to purchase waste processing services from a Contractor-owned, Contractor-operated facility through a fixed-price contract. DOE will provide the waste feedstock for processing but maintain ownership of the waste. The Contractor must: (a) provide private financing; (b) design the equipment and facility; (c) apply for and receive required permits and licenses; (d) construct the facility and commission its operation; (e) operate the facility to process tank waste according to DOE specifications; and (f) deactivate the facility.

The TWRS Privatization (TWRS-P) project is divided into two phases, Phase I and Phase II. Phase I is a proof-of-concept/commercial demonstration-scale effort. The objectives of Phase I are to (a) demonstrate the technical and business viability of using privatized Contractors to process Hanford tank waste; (b) define and maintain adequate levels of radiological, nuclear, process, and occupational safety; (c) maintain environmental protection and compliance; and (d) substantially reduce life-cycle costs and time required to process the tank waste. The Phase I effort consists of three parts: Part A, Part B-1, and Part B-2.

Part A, which concluded in August 1998, was a 20-month period to establish technical, operational, regulatory, and financial elements necessary for privatized waste processing services at fixed-unit prices. This included identification by the TWRS-P Contractors and approval by DOE of appropriate safety standards, formulation by the Contractors and approval by DOE of integrated safety management plans, and preparation by the Contractors and evaluation by DOE of initial safety assessments. Of the 20-month period, 16 months was for the Contractors to develop the Part A deliverables and four months was for DOE to evaluate the deliverables and determine whether to authorize Contractors to perform Part B. Part A culminated in DOE's authorization on August 24, 1998, of BNFL Inc. to perform Part B-1.

Part B-1 is a 24-month period to (a) further the waste processing system design introduced in Part A, (b) revise the technical, operational, regulatory, and financial elements established in Part A, (c) provide firm fixed-unit prices for the waste processing services, and (d) achieve financial closure.

Part B-2 is a 16-year period to complete design, construction, and permitting of the privatized facilities; provide waste processing services for representative tank wastes at firm fixed-unit prices; and deactivate the facilities. During Part B-2, approximately 10% by volume (25% by activity) of the total Hanford tank wastes will be processed.

Phase II will be a full-scale production effort. The objectives of Phase II are to implement the lessons learned from Phase I and to process all remaining tank waste into forms suitable for final disposal.

An essential element of the TWRS-P Project is DOE's approach to safety regulation. DOE has specifically defined a regulatory approach and chartered a dedicated Office of Safety Regulation of the TWRS-P Contractor (Regulatory Unit). The DOE aim in proceeding with the safety regulation of the TWRS-P Contractor is to establish a regulatory environment that will permit privatization to occur on a timely, predictable, and stable basis. In addition, attention to safety must be consistent with that which would accrue from regulation by external agencies. DOE is patterning its radiological and nuclear safety regulation of the TWRS-P Contractor to be consistent with that of the U.S. Nuclear Regulatory Commission (NRC). For industrial hygiene and safety (IH&S), regulation is consistent with that of the Occupational Safety and Health Administration (OSHA).

The RL Manager has responsibility and authority for safety regulation and has assigned this authority to the RL Director of the TWRS-P Regulatory Unit (the Regulatory Official). This regulatory authority is exclusive to the regulation of the TWRS-P Contractor. The Regulatory Official is the formal point of execution for safety regulation of the TWRS-P Contractor.

The DOE requires the Contractor to integrate safety into all facets of work planning and execution. This Integrated Safety Management (ISM) process emphasizes that it is the Contractor's direct responsibility for ensuring that safety is an integral part of mission accomplishment. Like the approach taken by the NRC and OSHA, the privatized Contractor has primary responsibility for safety. The DOE, through its program, is responsible for ensuring that the Contractor establishes and complies with approved safety limits.

The relationship between DOE and the privatized Contractor performing work under a fixed-price contract is different than the relationship under traditional Management and Operations (M&O) contracts. For fixed-price contracting to be successful, this different safety relationship with the Contractor is accompanied by modified relationships among DOE's internal organizations. For example, the arrangement by which the RL Manager applies regulation to the TWRS-P Contractor should be a surrogate for an external regulator (such as the NRC or OSHA) with strong emphasis on independence, reliability, and openness.

Regulation by the RU in no way replaces any legally established external regulatory authority to regulate in accordance with their duly promulgated regulations nor relieves the Contractor from any obligations to comply with such regulations or to be subject to the enforcement practices contained therein.

All documents issued by the Office of Safety Regulation of TWRS-P Contractor are available to the public through the DOE/RL Public Reading Room at the Consolidated Information Center, Room 1012, Richland, Washington. Copies may be purchased for a duplication fee.

RECORD OF REVISION

Document Title: Review Guidance for the Revised Standards Approval Package for Construction Authorization

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Revision Date	Revision Number	Reason for Revision
8/31/99	0	New
1/00	1	Incorporate BNFL comments.

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Review Guidance for the Revised Standards Approval Package for Construction Authorization

1.0 INTRODUCTION

The Tank Waste Remediation System Privatization (TWRS-P) Contractor is required to submit a Construction Authorization Request (CAR). The U.S. Department of Energy's (DOE's) Richland Operations Office (RL), Office of Safety Regulation of the TWRS-P Contractor (Regulatory Unit), will evaluate the CAR and issue the Preliminary Safety Evaluation Report (PSER) and the Construction Authorization Agreement.[1] The guidance for review of the CAR submittal is contained in RL/REG-99-05, *Review Guidance for the Construction Authorization Request*.[2]

At least 14 weeks before the CAR is submitted, the Contractor is required to submit a revised Standards Approval (SA) Package that contains all necessary supporting documentation.

Paragraph C.2)(e) of Standard 4 of the Part B-1 Contract (page C-58) states:

> "The Contractor shall submit, sufficiently in advance of the submission (at least 14 weeks) of the Construction Authorization Request to enable review and approval by the Regulatory Official (RO), a revised Standards Approval Package [SAP], complete with all necessary supporting documentation. The four required elements of the Standards Approval Package may be incrementally submitted for review. The scope and content of the submittal shall be in accordance with the requirements for a Construction Authorization Request as stipulated in Section 4.3.2, *Contractor Input*, Items 6) and 8) of DOE/RL-96-0003[3]…"

Items 6 and 8 of DOE/RL-96-0003, Rev. 0, state the following:

> "The current SRD and the ISMP and an assessment of compliance to the SRD and the ISMP (note the changes relative to the SRD and the ISMP approved by the regulation action of Section 4.1)."

> "Analysis of radiological, nuclear, and process hazards for the final[4] design;" (the Hazard Analysis Report[5]).

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[1] The review and discussion period may be extended if the information submitted by the Contractor is insufficient in scope or depth for the Regulatory Official to determine that the approval conditions described in Section 3.3.3 of DOE/RL-96-0003, *DOE Regulatory Process for Radiological, Nuclear and Process Safety for TWRS Privatization Contractors*, Rev. 1, are met.

[2] Rev. 2 of the CAR Guide is being released in January 2000. This revision incorporates the RU's response to BNFL's comments on that revision.

[3] The Contract refers to Rev. 0 of DOE/RL-96-0003. However, the RU and BNFL have approved Revision 1 of DOE/RL-96-0003, in which the previous items 6 and 8 are now items D and 8, respectively.

[4] Note that the word *final* was removed in Revision 1 to DOE/RL-96-0003. The Contract refers to DOE/RL-96-0003, Revision 0.

[5] The Contract shows the Hazard Analysis Report (HAR) as a part of the Preliminary Safety Analysis Report submittal. Nonetheless, submittal of the HAR as part of the SA Package is also indicated in Table S4-1 of the Contract.

The purpose of this advanced submittal of the SA Package is to complete as much of the review of the SA Package (Safety Requirements Document [SRD], Integrated Safety Management Plan [ISMP], Hazard Analysis Report [HAR], and the Quality Assurance Program and Implementation Plan [QAPIP]) as possible within the 14-week period before receiving additional supporting information in the CAR. The SA Package review will then continue as part of the CAR review.[6] Approval of the SA Package, along with any conditions of approval, will be documented within the PSER.

This Guide has been developed for the Regulatory Unit (RU) reviewers to use in the limited review of the SA Package during the 14-week period before the CAR submittal. As further indicated in this Guide, full review of the SA Package requires information that will not become available until the RU receives the CAR submittal. Guidance for a full review of the SA Package information contained in the CAR submittal is provided in the CAR Review Guide (Section H), and for the most part, is not included in this Guide.

2.0 SCOPE

This Guide focuses on *changes* made to the SRD, ISMP, HAR, and QAPIP.[7] The SRD[8] requires that the Contractor submit documentation of the changes to the SRD and ISMP and the justification for changes that meet the criteria for an authorization basis change as identified in RL/REG-97-13.[9] The Contractor must also provide a self-assessment of compliance to the SRD and ISMP, as noted in Section 1.0 of this Guide.

Because the focus of this SA Package review is on the acceptability of changes to the SA Package and on the Contractor's assessment of compliance to the SRD and the ISMP, the review will not re-examine the approved SA Package.

The Regulatory Process document[10] identifies approval criteria for the CAR submittal. Among the CAR approval criteria, the following criteria are related to the SA Package:

1. "The Contractor's safety-related activities are being conducted according to its approved ISMP."[11]

2. "The Contractor's design complies with the design-related portions of the SRD."[12]

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[6] *Review Guidance for the Construction Authorization Request (CAR*), RL/REG-99-05, Rev. 2, January 2000.

[7] It is anticipated that the QAPIP will have been revised and reviewed by the RU immediately before this review. Therefore, QAPIP Review Guidance is not included in this document. A review of the consistency of the QAPIP with the ISMP is briefly discussed in Section 5.

[8] *Safety Requirements Document*, BNFL-5193-SRD-01, Rev. 2, Volume I, Section 3.6, "Maintenance of the SRD," December 1998.

[9] Supporting documentation for changes that do not require RU approval per RL/REG-97-13 need not be submitted with the SA Package but retained for RU review on site.

[10] *DOE Regulatory Process for Radiological, Nuclear and Process Safety for TWRS Privatization Contractors*, (Regulatory Process), DOE/RL-96-0003, Rev. 1, Section 3.3.3, "Authorization for Construction," and Section 4.3.2 "Contractor Input," July 1998.

[11] Ibid., Section 3.3.3, "Authorization for Construction," item 1.

[12] Ibid., item 3. The SAP will contain only limited design information. This portion of the SA Package review must largely await submittal of the CAR.

3. "Proposed changes to the SRD and ISMP are acceptable." [13]

The Part A Contract envisioned this review of the SA Package to be performed in the context of and in parallel with the review of the Preliminary Safety Analysis Report (PSAR) and the rest of the CAR submittal. However, the Contract was modified for Part B-1 to enable review of as much of the SA Package as possible in advance of the CAR submittal to facilitate the CAR review.

Guidance for reviewing all aspects of the SRD and ISMP, as necessary for CAR approval, is contained in the CAR Review Guide.[14] This SA Package Review Guidance concentrates on the portion of the review that can be completed primarily by examining the SA Package documentation provided 14 weeks before the CAR is submitted.

Review associated with approval criterion 1 above cannot be completed until the results associated with prior BNFL Inc. (BNFL) inspections are examined and integrated into a finding related to BNFL's safety-related activities. This portion of the review will be completed during the CAR review. A full review associated with approval criterion 2 above necessitates examination of information from the CAR not available at the time of the SA Package review. Most of the SA Package review related to this Guide is associated with approval criterion 3 above (i.e. that the changes to the SRD and ISMP are acceptable). For this review, the evaluation of the acceptability of changes to the SRD and ISMP is limited to the information documented in the SA Package.

Section 3, "Review of Changes to the SRD and ISMP," and Section 4, "Hazard Analysis Report," of this Guide are based on portions of the CAR Review Guide.[15] Section 3 has been reduced in scope in comparison to CAR Review Guide, Section H, "SRD and ISMP Acceptability and Compliance," to reflect the limited scope of the SA Package.

3.0 REVIEW OF CHANGES TO THE SRD AND ISMP

3.1 PURPOSE OF REVIEW

The purpose of this review is to determine whether changes to the Contractor's SRD and the ISMP are acceptable and whether the Contractor's assessment of SRD/ISMP compliance is adequate.

3.2 AREAS OF REVIEW

The reviewer will determine whether the Contractor's submittal is compliant with the approved SRD and ISMP. For example, if new implementing standards are selected for designing hazard controls, the Contractor is required to use, for selecting these standards, the methods described in

[13] Ibid., item 2.
[14] *Review Guidance for the Construction Authorization Request (CAR*), RL/REG-99-05, Rev. 2, Section H, January 2000.
[15] Ibid., Sections H, "SRD and ISMP Acceptability and Compliance," and Sections 4.1-4.4, respectively.

Appendix A to the SRD, Rev. 2.[16] In performing this portion of the review, the reviewer shall consider changes to the authorization basis[17] (SRD, ISMP, HAR, and QAPIP) that have been approved since issuance of the SRD, Rev. 2, and the ISMP, Rev. 4 (December 1998).

The reviewer will also determine whether the Contractor has provided an adequate assessment of compliance to the SRD and ISMP.[18] Adequacy is determined by reviewing the written "assessment of compliance to the SRD and ISMP" that is provided as part of the SA Package.

3.3 ACCEPTANCE CRITERIA

3.3.1 Acceptability Review

The reviewer will determine whether the Contractor's submittal on assessing compliance to the SRD and ISMP and the description and justification of changes to the SRD and ISMP contain sufficient information to evaluate the submittal against the criteria in Section 3.3.3, "Regulatory Acceptance Criteria," and is therefore ready for detailed review. If significant deficiencies are identified in the submittal, the Contractor will be requested to submit additional information before the start of the detailed review.

It should be understood, however, that acceptance criteria 1 and 2 in Section 3.3.3 below apply to the complete CAR submittal. Therefore, the information contained in the SA Package is not expected to be adequate to reach conclusions regarding criteria 1 and 2. Conclusions on these criteria will have to await completion of the CAR review.

Acceptance of the SA Package for review does not imply approval of the SA Package submittal because additional information in the CAR is needed to complete the review.

3.3.2 Regulatory and Contractual Requirements

The requirements for reviewing the Contractor's compliance to the SRD and ISMP are found in the Regulatory Process document.[19] The Regulatory Process document states that the submittal package shall consist of the following documentation:

> "The current SRD and the ISMP and an assessment of compliance to the SRD and the ISMP (note the changes relative to the SRD and ISMP approved by the [Standards Approval] regulatory action)."[20]

[16] *Safety Requirements Document*, BNFL-5193-SRD-01, Rev. 2, Volume II, Appendix A, "Implementing Standard for Safety Standards and Requirements Identification," December 1998.
[17] These have been referred to as Part B-1 "ABAR changes" in correspondence between the BNFL and the RU.
[18] *DOE Regulatory Process for Radiological, Nuclear and Process Safety for TWRS Privatization Contractors*, (Regulatory Process), DOE/RL-96-0003, Rev. 1, Section 4.3.2, "Contractor Input," item 6, July 1998.
[19] One of the requirements will not be addressed during the 14-week review, specifically that "the Contractor's safety-related activities are being conducted according to its approved ISMP." This requirement of the Regulatory Process Document (Section 3.3.3, "Authorization for Construction," item 1) will be addressed during the review of the CAR.
[20] Ibid. Section 4.3.2, "Contractor Input," item D.

In addition, the Regulatory Process document states that a construction authorization will be issued when the RO determines the following:

> "The Contractor's design complies with the design-related part of the updated SRD;"[21] and
>
> "The proposed changes to the SRD and ISMP are acceptable." [22]

Related regulatory and contractual requirements are found in Volume I of the SRD, Section 3.6, "Maintenance of the SRD"; Section 4.0, "Confirmation Process"; and Volume II, Appendix A, "Implementing Standard for Safety Standards and Requirements Identification." Related requirements are also found in the ISMP, Section 3.3.2, "Control of the Authorization Basis." Finally, a requirement for independent review and assessment of SRD changes is found in Section 4.0 of Volume I of the SRD and in the ISMP, Section 3.16.1.2.

3.3.3 Regulatory Acceptance Criteria

The SRD and the ISMP-related portions of the Contractor's SA Package submittal are acceptable if the following criteria are met:[23]

1. The Contractor's "assessment of compliance to the SRD and the ISMP" is adequate.

2. The Contractor's design complies with the design-related portions of the SRD. [24]

3. The proposed changes to the SRD and ISMP are acceptable.

4. The SRD complies with the requirement of the SRD, Volume I, Section 3.6, "Maintenance of the SRD," and Section 4.0, "Confirmation Process."

5. Revisions to the SRD comply with the SRD, Volume II, Appendix A, "Implementing Standard for Safety Standards and Requirements Identification."

6. The SRD and ISMP comply with the related ISMP, Section 3.3.2, "Control of the Authorization Basis."

7. The Contractor adequately follows the procedure described in the SRD and ISMP for independent review and assessment of SRD changes.[25, 26]

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[21] Ibid., item 3.
[22] Ibid., item 2.
[23] Alternative descriptions also may be acceptable if they are adequately justified and meet applicable requirements.
[24] The SA Package will contain only limited design information. This portion of the SAP review must largely await submittal of the CAR.
[25] *Safety Requirements Document*, BNFL-5193-SRD-01, Rev. 2, Volume I, Section 4.0, "Confirmation Process," December 1998.
[26] *Integrated Safety Management Plan*, BNFL-5193-ISP-01, Rev. 4, Section 3.16.1.2, "TWRS-P Project Safety Committee," December 1999.

These criteria are based on regulatory expectations as identified in the cited references. It is recognized that they are not all independent of each other and that they significantly overlap. They are intended to be used as a set to determine the overall acceptability of the revised SRD and ISMP.

3.4 REVIEW PROCEDURES

The reviewer will determine whether the Contractor's information outlined in the acceptance criteria in Section 3.3 of this Guide has been provided and is sufficiently detailed so that the reviewer has an adequate understanding of the justification for changes and assessment of compliance to the SRD and the ISMP. Based on the information provided in the SA Package, the reviewer will evaluate the acceptability of changes to the SRD and the ISMP and the adequacy of compliance to the SRD and the ISMP.

The following is a more explicit discussion of how the reviewer is to determine whether the seven regulatory acceptance criteria above are met:

1. **Regulatory Acceptance Criterion 1**: The Contractor's "assessment of compliance to the SRD and the ISMP" is adequate.

   This acceptance criterion has two aspects. First, the Contractor's assessment must address the CAR's compliance to the SRD. This relates to the approval criterion that states, "The Contractor's design complies with the design-related part of the SRD."[27] This task is accomplished by examining the design information provided to ensure that it accurately reflects commitments made in the SRD (both safety criteria and implementing standards). Completion of this portion of the review requires design information that may not be available until the CAR is submitted.

   Second, the reviewer must evaluate the adequacy of the Contractor's assessment of compliance to the ISMP. In this case, the reviewer shall review the Contractor's submittal on "assessment of compliance" to determine whether the assessment addresses all major aspects of the ISMP and indicates compliance or, in case of exceptions, provides an acceptable justification. In cases where the ISMP refers to portions of the SRD, the reviewer shall determine whether the references to the SRD are also consistent with the assessment. For example, the ISMP, Section 1.3.10, "Classification of Structures, Systems and Components," states, "General design requirements are applied as identified in Section 4.0 of the SRD for Safety Design Class SSCs. See SRD Safety Criterion 4.1-5 as an example." In this case, the reviewer would determine whether both the SRD and ISMP describe the same system for classification of structures, systems, and components (SSCs) classification and whether both are consistent with the Contractor's self-assessment.

   For either the SRD or ISMP, a significant portion of the "assessment of compliance" relies on the details contained in the CAR submittal. Therefore, the evaluation of

[27] *DOE Regulatory Process for Radiological, Nuclear and Process Safety for TWRS Privatization Contractors*, (Regulatory Process), DOE/RL-96-0003, Rev. 1, Section 3.3.3, "Authorization for Construction," item 3, July 1998.

"assessment of compliance" cannot be completed until the relevant portions of the CAR submittal are reviewed.

2. **Regulatory Acceptance Criterion 2**: The Contractor's design complies with the design-related portions of the SRD.[28]

   In the Regulatory Process document, this criterion is intended to apply to a review of the complete CAR submittal. For the SA Package review, the reviewer shall verify that the limited design description provided in the HAR is consistent with the design-related portions of the SRD (i.e., related safety criteria and standards identified in the SRD). This can be done on a sampling basis. A review of each component of the design is not expected for this SA Package review.

3. **Regulatory Acceptance Criterion 3**: The proposed changes to the SRD and ISMP are acceptable.

   Changes to the SRD, in comparison to the last approved version, fall into the following two categories:

   - Revisions to the SRD based on Authorization Basis Amendment Requests (ABARs) that were previously submitted by the Contractor and approved by the RU – The acceptability of such changes has been previously established through approval of the ABARs and is not within the scope of the revised SA Package review.[29]

   - Revisions to the SRD that were not the subject of any previous ABAR – The Contractor must support any such changes that meet the criteria for an authorization basis change as identified in RL/REG-97-13[30] with information that would normally accompany an ABAR. Information and documentation resulting from an application of Appendix A of the SRD can be expected to provide adequate supporting information for this purpose.

   The Contractor may revise the ISMP (1) without RU prior approval or (2) under a request for RU approval.

   The Contractor may revise the ISMP before the CAR is submitted without prior approval of the RU, if the revisions do not do any of the following:

   - Involve "either deletion or modification of a standard previously identified or established in the approved SRD."

   - Reduce a "commitment currently described in the Authorization Basis."

[28] The SAP will contain only limited design information. This portion of the SAP review must largely await submittal of the CAR.
[29] *Regulatory Unit Position on Contractor-Initiated Changes to the Authorization Basis*, RL/REG-97-13, Rev. 5, April 15, 1999.
[30] Supporting documentation for changes that do not require RU approval per RL/REG-97-13 do not need to be submitted with the SA Package but retained for RU review on site.

- "Result in a reduction in the effectiveness of any program, procedure, or plan described in the Authorization Basis." [31]

The Contractor may revise the ISMP through a request for RU approval to amend the authorization basis. In this case, the Contractor must provide justification as outlined[32] in RL/REG-97-13, Rev. 5. However, RL/REG-97-13 also states that documents submitted to the RU in connection with a regulatory action may be superceded by documents submitted in subsequent regulatory actions.

In these cases, the revised ISMP is acceptable if revisions do not (1) reduce a commitment currently described in the authorization basis or (2) result in a reduction in the effectiveness of any program, procedure, or plan described in the authorization basis, or (3) if reductions in commitments or effectiveness are proposed, the revision is acceptable if the Contractor adequately justifies the related change to the ISMP.

4. **Regulatory Acceptance Criterion 4**: The SRD complies with the requirement of the SRD Volume I, Section 3.6, "Maintenance of the SRD," and Section 4.0, "Confirmation Process."

Section 3.6 of Volume I of the SRD, "Maintenance of the SRD," states the following:

> "Consistency of the SRD with current design information, hazards assessment, hazards control, and selected standards during the SRD development is ensured by participating with the personnel responsible for design and hazards analysis activities in the SRD development process as well as through Independent Safety Review Team (ISRT) reviews of the SRD, HAR, and design information. Additionally, for design-related criteria, a review of the Safety Criteria against facility design will be conducted to ensure the Safety Criteria are met by the design…. Prior to issuance of the SRD as part of the Construction Authorization Request package, the SRD Safety Criteria will be modified as necessary to reflect new information relating to the design and operation of the TWRS-P Facility and the risk of the facility operation… Proposed changes to the SRD are evaluated for impact on safety and compliance with regulations and the authorization basis (including hazard and accident analysis). These changes are then reviewed and approved commensurate with the process applied to the original configuration, including regulatory approval prior to implementing changes that could be considered as decreasing the level of safety. The essential elements of DOE/RL-96-0004, *Process for Establishing a Set of Radiological, Nuclear, and Process Safety Standards and Requirements for TWRS Privatization*, as addressed in the original development of the SRD, are maintained, including the use of subject matter experts and the use of an equivalent level of review and approval of the proposed change."

The reviewer shall determine whether the revisions to the SRD and BNFL review of the SRD have been conducted according to the paragraph above. The revised SRD should be

[31] *Regulatory Unit Position on Contractor-Initiated Changes to the Authorization Basis*, RL/REG-97-13, Rev. 5, items 1, 3 and 5, pg. 4, April 15, 1999.
[32] Ibid., Section 3.6, p. 5.

compared with the currently approved SRD revision to determine whether revisions have been appropriately reviewed and approved. Any ad-hoc or unjustified revisions should be identified and BNFL should be requested to provide justification.

The SRD, Volume I, Section 4, "Confirmation Process" states the following:

> "The TWRS-P Project manager appointed the Independent Safety Review Team (ISRT) to coordinate and review safety issues. The ISRT provided oversight for the SRD and other documents that will comprise the authorization basis. The charter for the ISRT is contained in *TWRS Privatization Project Procedure Manual*, "Independent Safety Review Team" (BNFL 1997b). This charter defined the ISRT role in the development of TWRS-P Project safety deliverables including review of the plans and documents affecting safety to ensure they meet applicable contract, regulatory, and BNFL Inc. safety goals."

The reviewer shall examine the submittal to ascertain that the ISRT successfully executed the responsibilities assigned by the TWRS-P Project Manager.

5. **Regulatory Acceptance Criterion 5**: Revisions to the SRD comply with the SRD Volume II, Appendix A, "Implementing Standard for Safety Standards and Requirements Identification." Appendix A has the following major sections:

- 1.0 Introduction
- 2.0 Process Initiation
- 3.0 Identification of Work
- 4.0 Hazard Evaluation
  - 4.1 Identification of Hazards
  - 4.2 Identification of Potential Accident/Event Sequences
  - 4.3 Estimation of Consequences
  - 4.4 Estimation of Accident Frequencies
  - 4.5 Consideration of Common Cause/Common Mode Failures
  - 4.6 Definition of Design Basis Events
  - 4.7 Definition of Operating Environment
  - 4.8 Identification of Potential Controls
  - 4.9 Documentation
- 5.0 Development of Control Strategies
- 6.0 Identification of Standards
- 7.0 Confirmation of Standards
- 8.0 Formal Documentation
- 9.0 Recommendation.

The manner in which the HAR is required to reflect Appendix A is described in Section 4 of this Guide. Therefore, Section 4 of this Guide describes how to review Items 1.0 through 4.5, 4.8, and 4.9 of the outline of Appendix A above.

The SA Package is expected to contain information related to Sections 4.6, 4.7, and 5.0 above, but this information may not be complete. For example, quantitative analysis of all design basis events (DBEs) and consequent refinement of control strategies may not be available in the SA Package. All such information not included in the SA Package is

expected to be provided in the PSAR/CAR submittal. Review of the SA Package with respect to these sections should be addressed to the extent possible during the 14-week SA Package review. The reviewer is directed to CAR Guidance, Section 4.5 (Internal Design Basis Events), Section 4.6 (External Design Basis Events), and Section 4.7 (Hazard Controls).

However, Identification of Standards (6.0), Confirmation of Standards (7.0), Formal Documentation (8.0) and Recommendation (9.0) should be reflected in the SA Package submittal. Extracts of the key elements of Appendix A for this portion of the review (Review of Changes to the SRD and ISMP) are described below to guide the reviewer.

- Appendix A, Section 6, "Identification of Standards," which states, in part, the following:

  "Documentation of the standards and requirements identification process provides justification of the set selected and links each control strategy to its associated set of standards. The (following) information generated during standards selection is retained in database[33] form for each control strategy:

  - Control strategy
  - Engineering category
  - Service environment
  - Applicable design basis events
  - Applicable standards
  - Performance requirements
  - Testing/calibration requirements
  - In-service inspection requirements
  - Maintenance requirements
  - Quality level
  - Standards justification.

  This information is structured so it can be linked to the control strategies in the hazard schedule. This provides a link from the hazards through the control strategies to the standards. Not all of this information will be available early in the design. For example, it will not be possible to define maintenance and testing requirements until the design is mature.

  The standards identified through this activity shall be reflected in the SRD."

For new standards, the reviewer shall determine whether the Contractor has documented the standards selection process in the manner described above. While this information may not all be contained in the submittal, the reviewer shall review the database mentioned above to determine that the cited Appendix A provisions were observed.

Additionally, the reviewer should examine the submittal in the context of the supporting information described in the balance of Section 6.0 of the SRD, Volume II, Appendix A. This information addresses the specific BNFL approach towards implementing the

[33] BNFL has entitled the database Standards Identification Process Database.

standards selection process described in DOE/RL-96-0004, Rev. 1. This includes a description of the composition of the team of work activity experts and environment, safety and health standards experts, as well as a discussion of the use of "Engineering Categories" as the starting point for standards selection. Finally, Section 6.0 of Appendix A describes how tailoring of the standards is accomplished and how target reliabilities for Important to Safety SSCs are selected. The reviewer shall determine whether the Contractor's additional supporting information described in Section 6.0 of the SRD, Volume II, Appendix A, adequately supports the selection of standards.

- Appendix A, Section 7.0, "Confirmation of Standards," states the following:

  "Based on the recommendation of the process manager, the TWRS-P Project Manager requests the Project Safety Committee (PSC) to confirm the selected set of standards. The PSC defines a review approach, carries out the review, and documents the findings of the review. Comments by the PSC shall receive formal disposition by the Process Management Team."

For revisions to the SRD, the reviewer shall determine that the procedure described above, including documentation of the findings of the PSC review, has been followed. The reviewer shall also determine whether the comments of the PSC have received "formal disposition by the Process Management Team" (p. A-15).

- Appendix A, Section 8.0, "Formal Documentation," states the following:

  "Following confirmation by the PSC, … The results of the process shall be documented in the Safety Requirements Document (SRD). The SRD shall incorporate documentation supporting these results by reference. The SRD shall identify and justify the set of requirements and standards selected to provide adequate protection of workers, the public, and the environment."

For revisions to the SRD, the reviewer shall determine whether the SRD provides references to documentation of the standards selection process. The reviewer shall request BNFL to provide the documentation for these references to examine the integrity of the process, on a sampling basis.

- Appendix A, Section 9.0, "Recommendation," states the following:

  "The TWRS-P Manager of Operations certifies that the recommended set of standards, when properly implemented:

  1. Provides adequate safety.
  2. Complies with applicable laws and regulations.
  3. Conforms with the Top-Level Safety Standards and Principles."

For revisions to the SRD, the reviewer shall determine whether the Manager of Operations has certified the standards as indicated.

6. **Regulatory Acceptance Criterion 6**: The SRD and the ISMP comply with the related ISMP, Section 3.3.2, "Control of the Authorization Basis," which states the following:

> "The authorization basis for [the] TWRS-P Facility is considered as an element of the technical baseline for the facility. A configuration management program manages changes to the technical baseline. For further information concerning configuration management see ISMP Sections 1.3.16 and 5.3, "Configuration Management."

Paragraph 2 (c) of Standard 4 of the BNFL Contract[34] states the following:

> "The Contractor's Integrated Safety Management Plan shall conform with both RL/REG-97-13, *Regulatory Unit Position on Contractor-Initiated Changes to the Authorization Basis*…"

The review of the SA Package for this criterion is limited to verifying that changes to the SRD and ISMP were made according to approved procedures for controlling the authorization basis.

7. **Regulatory Acceptance Criterion 7**: The Contractor adequately follows the procedure described in the SRD and ISMP for independent review and assessment of SRD changes.[35, 36]

See the discussion of the SRD, Volume I, Section 4.0, "Confirmation Process" (Criterion 4), which is related to "independent review and assessment of SRD changes" (Criterion 7). Also, see the ISMP, Section 3.16.1.2, "TWRS-P Project Safety Committee," which states, in part, the following:

> "Project Safety Committee (PSC) provides advice to the TWRS-P Project and General Manager on matters related to safety."

For changes to the SA Package, the reviewer shall examine the PSC duties described in Section 3.16.1.2 of the ISMP and determine from review of the submittal whether the PSC has executed its responsibilities as described in the ISMP.

3.5 EVALUATION FINDINGS

If changes to the SA Package were acceptable after the 14-week review is completed, the reviewer will prepare input for the PSER,[37] stating that pending additional information to be provided in the CAR, the following has been determined:

[34] TWRS-P Contract No. DE-AC06-96RL13308 between DOE and BNFL Inc., dated August 24, 1998.
[35] *Safety Requirements Document*, BNFL-5193-SRD-01, Rev. 2, Section 4.0, "Confirmation Process," December 1998.
[36] *Integrated Safety Management Plan*, BNFL-5193-ISP-01, Rev. 4, Section 3.16.1.2, "TWRS-P Project Safety Committee," December 1999.
[37] The preliminary draft PSER addressing SRD and ISMP compliance will be finalized when the CAR review is completed.

The Contractor's SRD and ISMP have been reviewed against the regulatory acceptance criteria in Section 3.3.2 of this Guide and the following was determined:

- The Contractor's assessment of compliance to the SRD and ISMP is adequate.
- The Contractor's design complies with the design-related portions of the SRD.
- The proposed changes to the SRD and ISMP are acceptable.
- The SRD complies with the requirements of the SRD, Volume I, Section 3.6, "Maintenance of the SRD."
- Revisions to the SRD comply with the SRD, Volume II, Appendix A, "Implementing Standard for Safety Standards and Requirements Identification."
- The SRD and ISMP comply with the related ISMP, Section 3.3.2, "Control of the Authorization Basis."
- The Contractor adequately followed the procedure described in the SRD and ISMP for independent review and assessment.

The reviewer concludes that the Contractor has complied with the general requirements for changes to the SRD and ISMP. Any exceptions should be noted and stated in a way to provide the Contractor with a clear understanding of the necessary revisions to satisfy the RO. The reviewer may recommend to the RO that the submittal be conditionally approved with provisions for the Contractor to submit additional information within a specified timeframe.

4.0 HAZARD ANALYSIS REPORT

Guidance for the review of the HAR is provided in Sections 4.1 - 4.4 of this Guide, which are essentially the corresponding sections from the CAR Review Guidance for the convenience of the reviewer.

4.1 PROCESS SAFETY INFORMATION

4.1.1 Purpose of Review

The purpose of this review is to determine whether the Contractor's submittal adequately describes process safety information that meets the regulatory and contractual requirements, including the requirement of Safety Criterion 3.1-2 in the SRD.

4.1.2 Areas of Review

The reviewer will determine whether the Contractor's submittal adequately describes process safety information, including information on the hazardous materials, technology, and equipment used. Process safety information is used to support the process description and process theory

sections of the Preliminary Safety Analysis (PSA) and allows the operators to identify and understand the hazards of processes involving radioactive materials and process chemicals. The Contractor should provide the appropriate information in the HAR.

4.1.3 Acceptance Criteria

4.1.3.1 Acceptability Review

The reviewer will determine whether the Contractor's submittal on process safety information contains sufficient information to evaluate the submittal against the criteria in 4.1.3.3, "Regulatory Acceptance Criteria," and is therefore ready for detailed review. The Contractor should clearly describe the process safety information and include a table or matrix of cross-references to help the reviewer locate the process safety information if it is located in several different sections of the submittal (such as the process description, facility description, hazard analysis results, appended drawings, and diagrams).

The information should be sufficiently detailed to allow the reviewer to verify that a complete set of process safety information has been provided. If significant deficiencies are identified in the submittal, the Contractor will be requested to submit additional information before the start of the detailed review.

4.1.3.2 Regulatory and Contractual Requirements

The requirements for process safety information are found in the Regulatory Process document,[38] which states that the Contractor shall provide process safety information as part of the assurance that "the radiological, nuclear, and process hazards associated with facility operation…have been adequately documented in a controlled PSAR to establish a basis for safe operation and an unambiguous definition of the safe-operating envelope."

For all processes regulated by the Occupational Safety and Health Administration or U.S. Environmental Protection Agency, the Contractor shall comply with process safety information requirements specified by 29 CFR 1910.119, "Process Safety Management of Highly Hazardous Chemicals," and 40 CFR 68, "Chemical Accident Prevention Provisions," as applicable.

Related regulatory and contractual requirements are found in the SRD.[39] The following safety criterion applies directly to process safety information. Safety Criterion 3.1-2 states, in part, the following:

> "A compilation of written process safety information shall be completed before conducting the process hazard analysis. The compilation of written process safety information enables the employer and the employees involved in operating the process to identify and understand the hazards posed by those processes involving radioactive

[38] *DOE Regulatory Process for Radiological, Nuclear and Process Safety for TWRS Privatization Contractors*, (Regulatory Process), DOE/RL-96-0003, Rev. 1, Section 3.3.3, "Authorization for Construction," item 8, July 1998.
[39] *Safety Requirements Document*, BNFL-5193-SRD-01, Rev. 2, December 1998.

chemicals and process chemicals considered to pose a hazard. This process safety information shall include information pertaining to hazards of the materials used or produced by the process, information pertaining to the technology of the process, and information pertaining to the equipment in the process."

In BNFL's ISMP,[40] the implementing code and standard[41] that applies to Safety Criterion 3.1-2 is Section 5.1, "Process Safety Information."

4.1.3.3 Regulatory Acceptance Criteria

The Contractor's process safety information is acceptable if the following criteria are met:[42]

1. The Contractor provides hazardous material information, including toxicity information, permissible exposure limits, physical data, reactivity data, corrosivity data, thermal and chemical stability data, and hazardous effects of inadvertent mixing of different materials that could conceivably occur. The Contractor may reference the appropriate Material Safety Data Sheet for the hazardous materials.

2. The Contractor provides process technology information, including block flow or simplified process flow diagrams, process chemistry, maximum intended inventory, and safe upper and lower limits for parameters controlled for safety reasons (such as temperatures, pressures, flows, and compositions) and evaluates the consequences of deviations.

3. The Contractor provides process equipment information, including materials of construction, piping and instrument diagrams, electrical information, relief system design and design basis, ventilation system design, design codes and standards used, material and energy balances, and safety systems (e.g., interlocks, detection systems, and suppression systems).

The process safety information should be sufficiently detailed to permit an understanding of the accident and hazard analysis for the proposed design. At this time, the reviewer is not making a final determination of the safety of the operations.

4.1.4 Review Procedures

The reviewer will determine whether the Contractor's information outlined in the acceptance criteria in Section 4.1.3 in this Guide has been provided and is sufficiently detailed so that the reviewer has an adequate understanding of the process safety information. Following the review, the reviewer will prepare input to the PSER, covering the material reviewed.

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[40] *Integrated Safety Management Plan*, BNFL-5193-ISP-01, Rev. 4, Section 5.1, "Process Safety Information," December 1998.

[41] This reference to the ISMP may be replaced by reference to a consensus standard at the time of the 14-week SA Package submittal.

[42] Alternative descriptions also may be acceptable if they are adequately justified and meet applicable requirements.

4.1.5 Evaluation Findings

The reviewer will prepare material for the PSER, stating whether the Contractor has demonstrated a commitment to compile and maintain complete, current, and accurate process safety information. If acceptable, the report should include a summary statement of what was reviewed and why the reviewer finds the submittal acceptable. For example, the reviewer can document the review as follows:

> The process safety information has been reviewed against the acceptance criteria in Section 4.1.3 in this Guide and found to be acceptable. The Contractor has compiled an adequate list of the hazardous chemicals, the process technology, and the process equipment so that the information is available for the PSA. The compilation adequately identifies the process hazards. The information provided in the submittal is consistent with the current status of the facility and process design.

Any exceptions should be noted and stated in a way to provide the Contractor with a clear understanding of the revisions necessary to satisfy the RO. The reviewer may recommend to the RO that the submittal be conditionally approved with provisions for the Contractor to submit additional information within a specified timeframe.

4.2 TRAINING AND QUALIFICATION OF THE HAZARD TEAM

4.2.1 Purpose of Review

The purpose of this review is to determine whether the Contractor's submittal adequately describes the proposed training and qualification to reasonably ensure that the hazard analysis (HA) team personnel have the knowledge and skills necessary to perform HAs in compliance with the SRD and the ISMP and in a manner that ensures adequate protection of the health and safety of the public, facility and co-located workers, and the environment.

4.2.2 Areas of Review

The reviewer will determine whether the Contractor's submittal adequately describes the training and qualification for the HA team personnel. The reviewer will examine the method of team selection, team staffing with experienced and knowledgeable individuals from varying disciplines, team qualifications, team member knowledge of the specific methodology being used, team member knowledge of the specific process(es) being evaluated, and team members' areas of expertise. For an overall review of training and qualification, see Section 3.4 in the CAR Guide.

4.2.3 Acceptance Criteria

4.2.3.1 Acceptability Review

The reviewer will determine whether the Contractor's submittal on the HA team's training and qualification contains sufficient information to evaluate the submittal against the criteria in

4.2.3.3, "Regulatory Acceptance Criteria," and is therefore ready for detailed review. If significant deficiencies are identified in the submittal, the Contractor will be requested to submit additional information before the start of the detailed review.

4.2.3.2 Regulatory and Contractual Requirements

The requirements for training and qualification of the HA team are found in the Regulatory Process document,[43] which states that the Contractor shall demonstrate that it is "qualified by reason of experience and training to perform the proposed construction."

Related regulatory and contractual requirements are found in the SRD. The following safety criterion applies to training and qualification of the HA team. Safety Criterion 3.1-1 states, in part, the following:

> "The process hazard analysis shall be performed by a team with expertise in engineering and process operations, and the team shall include at least one member who has experience and knowledge specific to the process being evaluated. Also, one member of the team must be knowledgeable in the specific process hazard analysis methodology being used."

BNFL has also cited the following implementing code and standard for performing HA: the ISMP, Section 5.5, "Process Hazards Analysis," which states, in part the following:

> "The PHA is performed in accordance with the requirements of the TWRS-P Project Quality Assurance Plan. This includes establishment of personnel training and qualification requirements, confirming that personnel meet these requirements, application of management reviews, and documentation of results."

The following regulation applies to this review:

- 10 CFR 830.120, "Quality Assurance Requirements," Sections (a)(1)(iii), (b)(1), (c)(1)(ii), (c)(1)(iii), (c)(1)(iv), (c)(2)(iv), and (c)(3).

In addition, the following two regulations apply to this area of review if the facility has a chemical inventory that exceeds the threshold quantity listed in the two regulations:

- 29 CFR 1910.119, "Process Safety Management of Highly Hazardous Chemicals," Section (e)(4)

- 40 CFR 68.67, "Process Hazard Analysis in the Accidental Release Prevention Requirements," Section (d).

These two requirements state the following:

[43] *DOE Regulatory Process for Radiological, Nuclear and Process Safety for TWRS Privatization Contractors*, (Regulatory Process), DOE/RL-96-0003, Rev. 1, Section 3.3.3, "Authorization for Construction," item 5, July 1998.

> "The process hazard analysis shall be performed by a team with expertise in engineering and process operations, and the team shall include at least one employee who has experience and knowledge specific to the process being evaluated. Also, one member of the team must be knowledgeable in the specific process hazard analysis methodology being used."

4.2.3.3 Regulatory Acceptance Criteria

The Contractor's training and qualification submittal for the HA team personnel is acceptable if it meets the following criteria:[44]

1. The Contractor's method for selecting the HA team is acceptable.

2. The Contractor staffs the HA team with experienced and knowledgeable individuals from varying disciplines.

3. The Contractor provides adequate information on the qualifications of team members.

4. The Contractor demonstrates that team members are knowledgeable about the specific methodology being used and about the specific processes being evaluated.

4.2.4 Review Procedures

The reviewer will determine whether the Contractor's information outlined in the acceptance criteria in Section 4.2.3 in this Guide has been provided and is sufficiently detailed so that the reviewer has an adequate understanding of the HA team training and qualification. In addition, the reviewer will verify that the team composition and qualifications of the team leader and team members are adequately described. Following the review, the reviewer will prepare input to the PSER, covering the material reviewed.

4.2.5 Evaluation Findings

The reviewer will prepare input for the PSER, stating whether the Contractor has submitted and made appropriate commitments for training and qualification of the HA team. The report should include a summary statement of what was reviewed and why the reviewer finds the submittal acceptable. For example, the reviewer can document the review as follows:

> The Contractor's submittal on training and qualification of the HA team has been reviewed against the acceptance criteria in Section 4.2.3 in this Guide and found acceptable. The Contractor used an expert, knowledgeable HA team. Accordingly, the reviewer finds that the Contractor's proposed training and qualification reasonably ensure that the HA team personnel have the knowledge and skills necessary to perform the HAs. The information provided in the submittal is consistent with the current status of the facility and process design.

[44] Alternative descriptions also may be acceptable if they are adequately justified and meet applicable requirements.

Any exceptions should be noted and stated in a way to provide the Contractor with a clear understanding of the revisions necessary to satisfy the RO. The reviewer may recommend to the RO that the submittal be conditionally approved with provisions for the Contractor to submit additional information within a specified timeframe.

4.3 HA METHODS

4.3.1 Purpose of Review

The purpose of this review is to determine whether the Contractor's submittal adequately describes its HA methods and complies with the SRD and ISMP. This review will also provide confidence that the Contractor's HA methods will result in a facility design, construction, operation, maintenance, and deactivation that protects the health and safety of the facility and co-located workers, the public, and the environment.

4.3.2 Areas of Review

The reviewer will determine whether the Contractor's submittal adequately describes the HA methods used in the HA. Appendix A, Section 4.0, "Hazard Evaluation," of the SRD identifies nine elements of hazard evaluation as identified below. Review of the methods used for the first five elements is addressed in this section. The remaining four elements are not within the scope of this SA Package review but are addressed in subsequent sections in the CAR Guide.

1. **Identifying Hazards** – Hazards associated with the facility process, design, and operations are systematically identified.

2. **Identifying Potential Accident/Event Sequences** – Potential accidents are examined in a structured, systematic approach.

3. **Estimating Accident Consequences** – The consequences for postulated accidents are examined.

4. **Estimating Accident Frequencies** – Internal and external accident frequencies are estimated.

5. **Considering Common-Cause and Common-Mode Failures** – Credible common-cause events such as natural phenomena events, external man-made events, loss of electrical power, fire, internal missiles, and internal flooding are considered.

6. **Defining DBE** – A set of internal and external DBEs that define a set of bounding performance requirements for the SSCs relied on to control the hazards is identified. External DBEs are defined by the SRD, Safety Criteria 4.1-3 and 4.1-4. Guidance for reviewing internal and external DBEs is provided in Sections 4.5 and 4.6, respectively, in the CAR Guide.

7. **Defining Operating Environment** – A set of bounding operating conditions in which Important to Safety SSCs must function is identified. The operating environment

includes temperature, pressure, humidity, radiation levels, and chemical environment. Guidance for reviewing the definition of operating environment is provided in Section 4.5, "Internal Design Basis Events," in the CAR Guide.

8. **Identifying Potential Control Strategies** – Potential hazard control strategies are identified to manage each potential accident. Guidance for reviewing the control strategies is provided in Section 4.7 in the CAR Guide.

9. **Documenting the Hazard Evaluation** – The hazard evaluation is documented in a HAR. Guidance for reviewing documentation of the HA results is provided in Section 4.4 in this Guide.

In addition to the nine elements of hazard evaluation, the methods for identifying assumptions and analyzing uncertainty will be evaluated. Assumptions that affect the estimation of the frequency or consequences for each potential accident should be identified. Significant uncertainties identified during the HA should also be identified.

4.3.3 Acceptance Criteria

4.3.3.1 Acceptability Review

The reviewer will determine whether the Contractor's submittal on HA methods contains sufficient information to evaluate the submittal against the criteria in Section 4.3.3.3, "Regulatory Acceptance Criteria," and is therefore ready for detailed review. The reviewer will determine whether the HAR methodology is sufficient to support the PSA, (i.e., definition of DBEs [CAR Guide Sections 4.5 and 4.6] and the analysis of hazard control features [CAR Guide Section 4.7]), and is therefore acceptable for detailed review. If significant deficiencies are identified in the submittal, the Contractor will be requested to submit additional information before the start of the detailed review.

4.3.3.2 Regulatory and Contractual Requirements

The requirements for HA methods are found in the Regulatory Process document and apply to all parts of the methods evaluation:

- Approval Condition: "Construction Authorization will be issued upon determination by the Regulatory Official that: …The radiological, nuclear, and process hazards associated with facility operation, including those from postulated accidents, have been *adequately assessed* [emphasis added]…to establish a basis for safe operation and an unambiguous definition of the safe-operating envelope."[45]

- Submittal Requirement: "The PSAR shall contain…an analysis of radiological, nuclear, and process hazards for the design."[46] (This is in reference to the Contractor's HAR.)

[45] *DOE Regulatory Process for Radiological, Nuclear and Process Safety for TWRS Privatization Contractors*, (Regulatory Process), DOE/RL-96-0003, Rev. 1, Section 3.3.3, "Authorization for Construction," item 8, July 1998.
[46] Ibid., Section 4.3.2, "Contractor Input," item 8.

Regulatory and contractual requirements related to the hazard evaluation elements are also found in the SRD, ISMP, and the Regulatory Process document. Requirements that apply to specific elements include the following:

1. **Identifying Hazards –** Safety Criterion 3.1-1; Safety Criterion 9.1-7; and Section 3, "Identification of Work," and Section 4.1, "Identification of Hazards," of Appendix A in the SRD apply to identifying hazards.

2. **Identifying Potential Accident/Event Sequences –** Safety Criterion 3.2-1; Section 4.2, "Identification of Potential Accident/Event Sequences," of Appendix A in the SRD; and ISMP, Section 1.3.6, "Accident Analysis," apply to identifying potential accident sequences.

3. **Estimating Accident Consequences –** Safety Criterion 3.1-3; Safety Criterion 3.1-4; and Section 4.3, "Estimation of Consequences," of Appendix A in the SRD apply to estimating accident consequences.

4. **Estimating Accident Frequencies –** Section 4.4, "Estimation of Accident Frequencies," of Appendix A in the SRD applies to estimating accident frequencies.

5. **Considering Common-Cause and Common-Mode Failures –** Section 4.5, "Consideration of Common Cause/Common Mode Failures," of Appendix A in the SRD applies to common-mode/common-cause failures.

Other applicable requirements include Section 4.9, "Documentation," of Appendix A in the SRD, which states that the HAR shall include the following:

> "*Assumptions affecting the release* [emphasis added] (material at risk, energy available, etc)…Hazard evaluation documentation shall be included in the SRD by inclusion or by reference. This documentation shall include the following: …*Clear identification of assumptions* [emphasis added] (e.g., quantity and form of material at risk, rate of release and relevant process conditions) that may drive or inhibit the potential accident must be clearly identified."

Another applicable requirement is Appendix A, Section 3.1, "Identification of Work," of the SRD, which states, "The status of design, work descriptions, and operational conditions, including anticipated operations and accidents along with associated *uncertainties* [emphasis added] also are included in the HAR."[47] Additionally, the ISMP[48] states the following:

> "A conservative approach to accident consequence analysis is used in terms of input assumptions, boundary conditions, and modeling techniques. As the process and facility design mature, the modeling is refined to eliminate unnecessary conservatism. *This strategy is consistent with risk-based approaches that allow the use of uncertainty analysis* [emphasis added] to better identify the impact of assumptions and state of knowledge on results from the safety analyses."

[47] *Safety Requirements Document*, BNFL-5193-SRD-01, Rev. 2, Section 3.1, "Identification of Work," December 1998.
[48] *Integrated Safety Management Plan*, BNFL-5193-ISP-01, Rev. 4, Section 1.2, "Summary," December 1999.

4.3.3.3 Regulatory Acceptance Criteria

The submittal is acceptable if the HA methods are performed for the following functions: feed receipt, pretreatment, low-activity waste immobilization, high-level waste immobilization, product and secondary waste handling, and the balance of facility. These functions are assessed for the following elements:[49]

1. **Identifying Hazards –** This section is acceptable if the Contractor identifies hazards that include those conceived based on analysis of the specific facility and process, incidents at similar facilities, and hazards identified in analyzing other facilities. These should include the hazards identified in the HAR, Initial Safety Analysis Report (ISAR), Design Safety Features Deliverable, and any other significant hazard identified through the design process; however, the reviewer is cautioned that previously identified hazards may no longer be applicable due to changes in the process, equipment, or design.

   The Contractor shall compile, based on the identified work, a list of hazardous materials and energy sources associated with the facility processes, design, and operations. This compilation provides information used to identify potential accidents resulting in the uncontrolled release of hazardous material or energy to facility and co-located workers, the public, and the environment. The Contractor should use a systematic approach to ensure that all potential hazards from both natural and man-made sources originating from outside and inside the facility are addressed. The chemical characteristics of chemicals and potential process byproducts should be addressed. The process for identifying hazards should include developing a chemical interaction matrix to determine the compatibility of the process reagents with each other, with the waste streams, and with process byproducts. The hazard identification should also list the hazards of holding chemicals for long periods, considering the effects of temperature, humidity, pressure, and deterioration of vessels, seals, and piping.

   A hazard map, or equivalent tool, should be used to ensure comprehensive coverage of processes, systems, and operations across multiple locations. The applicable HA results should be mapped to each specific facility, cell, or equipment location. Information should be provided concerning chemical inventory, equipment capacities, energy sources, unique characteristics associated with the facility or equipment location (e.g., temperature, organic material, and pressure), and unique configuration (e.g., interfaces, existence of ventilation, and controls). The hazard information provided should do the following:

   - Ensure that all hazards are identified.
   - Address all modes of operation including startup, normal operation, shutdown, maintenance, and deactivation.
   - Adequately consider initiation of, or contribution to, potential accident sequences by human error.

[49] Alternative descriptions also may be acceptable if they are adequately justified and meet applicable requirements.

The Contractor has identified the hazard and operability analysis (HAZOP) methodology as its choice for identifying hazards.[50] The HAZOP should be performed according to commonly accepted industry guidelines. SRD Safety Criterion 3.1-1 requires that the HAZOP methodology used will conform to that outlined in the American Institute of Chemical Engineers (AIChE), *Guidelines for Hazard Evaluation Procedures*.[51]

2. **Identifying Potential Accident/Event Sequences** – This section is acceptable if the Contractor summarizes accident sequences. In addition, the identified sequences must provide sufficient detail for estimating the unmitigated consequences and frequency of each accident. These estimates may be quantitative, semi-quantitative (i.e., order of magnitude), or qualitative (e.g., high, medium, low, etc., based on expert judgment). The accident sequences selected should result in consequences of at least severity levels 1, 2, or 3, as defined in Appendixes A and B in the SRD.

   The Contractor should also ensure that accidents with common consequences are combined into one accident scenario to ensure that the risks of potential higher frequency events are properly evaluated. Numerical estimates are not required or expected for all potential accident sequences. The level of precision required is that necessary to ensure that the Radiological Exposure Standards (RES), chemical risk exposure standards, and safety objectives[52] are met, as well as the associated risk goals. Where reliable data are not available to support this determination, conservative application of engineering judgment to complete the estimation process is expected. Additional guidance for accident selection and analysis can be found in Chapter 2 of NUREG/CR-6410.[53] The guidance in this document is not a requirement for BNFL. However, it does contain citations to several documents discussing standard hazard evaluation techniques and provides examples of accident scenario descriptions. This information may be used by BNFL and provides useful background information for the CAR review.

   The Contractor should include the following accident sequence information:

   - The method for selecting potential accident sequences that links initiating events with prevention and mitigation measures and other contributing phenomena.

   - The methods used to bin potential accidents into appropriate categories for risk and to select specific cases that will be analyzed in more detail.

   - The methods for selecting accident sequences that are both comprehensive and credible.

   - The Contractor's evaluation of secondary events directly caused by external

[50] *Integrated Safety Management Plan*, BNFL-5193-ISP-01, Rev. 4, Sections 1.3.4 and 5.5, both entitled "Process Hazards Analysis," December 1999.
[51] *Guidelines for Hazard Evaluation Procedures*, Second Edition with Worked Examples, Center for Chemical Process Safety, Chapters 4-6, AIChE, 1992.
[52] *Top-Level Radiological, Nuclear, and Process Safety Standards and Principles for TWRS Privatization Contractors* (Top-Level Standards), DOE/RL-96-0006, Rev. 1, Section 3.0, "Radiological and Nuclear Safety Objectives," July 1998.
[53] *Nuclear Fuel Cycle Facility Accident Analysis Handbook*, NUREG/CR-6410, Chapter 2, U.S. Nuclear Regulatory Commission, March 1998.

events (e.g., hazards from other facilities, aircraft crashes, pipeline ruptures, and truck crashes).

The interactions of identified hazards and proposed controls should be considered, including interactions between systems, to ensure that the facility's overall level of risk is acceptable. The Contractor should also address accidents resulting from process deviations (e.g., high temperature or high pressure), initiating events internal to the facility (e.g., fires or explosions), and hazardous credible external events (e.g., floods, high winds, earthquakes, and airplane crashes). The Contractor should justify its determination that certain events are incredible and therefore not subject to analysis in the PSA.

3. **Estimating Accident Consequences –** This section is acceptable if the Contractor provides an estimate of the accident consequences. This may be a qualitative assessment based on sound engineering judgment or a traceable reference to a quantitative or semi-quantitative evaluation. One purpose of this estimate is to provide the basis for assigning the potential accident sequence to the correct severity level, as defined in Appendixes A and B in the SRD. The Contractor should provide the explicit basis for unmitigated accident consequences. The basis for unmitigated accident consequences shall not take credit for any active or passive SSCs or administrative controls that could reduce the consequences of the accident,[54] unless adequate justification is provided by the Contractor.[55]

The Contractor should describe the methods for developing the source terms, transport models, and atmospheric dispersion and consequence models. For internal doses, the Contractor should ensure that the proper dose conversion factors have been used to calculate the total effective dose equivalent.

Because the Contractor generally may use either quantitative or qualitative analysis methods for estimating the risk from potential accidents, but must use at least semi-quantitative methods to estimate the risks for DBEs, the guidance for reviewing DBE calculations has been consolidated into Sections 4.5 and 4.6 in the CAR Guide. Acceptable methods that provide detailed guidance, formulas, and data to model the consequences of radiological releases can be found in Chapters 3, 4, and 5 of NUREG/CR-6410.[56] Other acceptable methods are found in DOE-HDBK-3010-94,[57] which provides data for estimating airborne release and respirable fractions. NUREG/CR-6410 and DOE-HDBK-3010-94 are not requirements documents for BNFL as identified in the SRD; the Contractor may use other methods of estimating releases.

Section 4.3.2, "Accident Analysis," of Appendix A of the SRD states that the accident analysis shall consider inventory of material at risk; respirable release fraction; airborne

[54] *Safety Requirements Document*, BNFL-5193-SRD-01, Rev. 2, Appendix A, Section 4.3.1, "Accident Severity Level Identification," pg. A-4, , December 1998.
[55] *Review of the BNFL Design Safety Features Submittal*, RL/REG-99-10, Rev. 0, Section 4.3.2.3, "Evaluation of Unmitigated Events," pg. 7, April 12, 1999.
[56] *Nuclear Fuel Cycle Facility Accident Analysis Handbook*, NUREG/CR-6410, Chapter 2, U.S. Nuclear Regulatory Commission, Chapters 3, 4, and 5, March 1998.
[57] *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, Vols. 1 and 2, DOE-HDBK-3010-94, U.S. Department of Energy, 1994.

material release fraction; bounding atmospheric dispersion coefficients, if appropriate; radiological composition of the material released; external radiation field; and exposure time.

The potential consequences of releases of hazardous chemicals must also be assessed. The consequence estimates will address consequences to facility and co-located workers and the public. The Contractor has committed to take additional measures to mitigate or prevent releases of hazardous chemicals that could exceed Emergency Response Planning Guide (ERPG)-2 (or equivalent limits) for exposure to facility and co-located workers or the public. The Contractor should evaluate chemical consequences and determine which events could lead to ERPG-2 exposures or other levels of chemical exposure that could lead to similar consequences. Risk from chemical hazards should be managed as specified in the SRD. Acceptable methods for chemical quantitative assessments and documentation can be found in AIChE's *Guidelines for Chemical Process Quantitative Risk Analysis,*[58] and in *Guidelines for Consequence Analysis of Chemical Releases*.[59]

The Contractor should present the method for categorizing consequences for use in binning potential accident sequences. If the Contractor is using qualitative criteria to bin consequences, then the method should provide criteria for qualitative binning. The method the Contractor selects should recognize that greater uncertainty exists in the qualitative binning of consequences. The estimation method should ensure that adequate conservatism is provided, given the greater uncertainty inherent in qualitative estimates. Table 3-3 of DOE-STD-3009-94[60] provides a sample table to illustrate a qualitative consequence estimation technique. DOE-STD-3009-94 is not a requirement document for BNFL as identified in the SRD. The Contractor may develop an acceptable alternative if it is adequately justified.

4. **Estimating Accident Frequencies** – This section is acceptable if the Contractor provides an adequate technical basis and method to estimate accident frequencies. The Contractor may estimate the frequency of accident initiators using engineering judgment or, if reliability data exist, more formal quantitative techniques such as fault or event trees. Criteria should be provided for assigning accidents to pre-selected initiation frequency ranges. If the Contractor uses qualitative criteria to bin accident frequencies, then criteria should be provided for qualitative as well as quantitative binning. It should be recognized in the criteria that there can be greater uncertainty in the qualitative binning of frequencies. Section 3.3.2.3.5, "Accident Selection," and Table 3-4 in DOE-STD-3009-94 provide guidance on using qualitative estimation of frequencies.

   The frequencies of concern are those for releasing radioactive or hazardous materials. The frequency of release is the initiating event's frequency of occurrence times the frequency of failure of the preventative and mitigative control strategies. The Contractor should provide information about both the estimated frequency of the initiating event and the estimated frequency of failure of the accident sequences' preventative and mitigative

[58] *Guidelines for Chemical Process Quantitative Risk Analysis*, Center for Chemical Process Safety, AIChE, 1999. This guidance is out of print but scheduled for revision and reissue in summer 2000.
[59] *Guidelines for Consequence Analysis of Chemical Releases*, Center for Chemical Process Safety, AIChE, 1999.
[60] *Preparation Guide for the U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*, DOE-STD-3009-94, Table 3-3, U.S. Department of Energy, 1994.

control strategies. To evaluate the HA methods, these estimates may be qualitative, quantitative, or both.

The Contractor should describe the method for determining unmitigated accident frequencies. The method should not credit any active or passive SSCs or administrative controls that could reduce the frequency of the accident.

The Contractor should provide an adequate basis for estimating frequencies using either engineering judgment or more formal analytical techniques. While verifiable quantitative estimates are preferred, in many cases they will not be available. Moreover, in many cases the hazard severity may not warrant quantitative analysis. Qualitative estimates of the accident frequencies are acceptable if the estimates are based on sound engineering judgment and the basis is provided. The engineering judgment should be based on conservative estimates that bound the results. The basis for the estimate should also include the reason why the qualitative estimate is conservative. The methods for ensuring conservative qualitative estimates and the criteria used should be documented.

If other analytical techniques (e.g., fault tree and event tree) are used, the method for calculating frequencies and the procedure for selecting associated data (e.g., reliability, probability of failure on demand, or failure frequency) must be documented. Detailed guidance[61] for methods of performing frequency analysis can be found in the following documents:

- NUREG/CR-2300, *PRA Procedures Guide – A Guide to the Performance of Probabilistic Risk Assessments for Nuclear Power Plants*, Vols. 1 and 2.[62]

- AIChE *Guidelines for Chemical Process Quantitative Risk Analysis*.[63]

Adherence to Probabilistic Risk Assessment (PRA) methods in NUREG/CR-2300 is not a requirement for BNFL as identified in the SRD. The reference is cited as a guide to the SA Package reviewer on general PRA techniques. It is recognized that some of the examples and systems analyzed in NUREG/CR-2300 are specific to nuclear power plants and are not directly applicable to BNFL. However, many of the PRA techniques (e.g., fault tree construction and event tree construction) are applicable to analyzing accident scenarios for any type of facility and may be used by BNFL.

Guidance on estimating equipment reliability data can be found in the following documents:

- WASH-1400, *Reactor Safety Study: An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants*[64]

[61] In Section 4.0 of this Guide, when additional "guidance" is cited, the reviewer is instructed to treat the material as such. The only regulatory "requirement" is IEEE-1023, which is referred to in Safety Criterion 4.3-6 of the SRD.
[62] *PRA Procedures Guide – A Guide to the Performance of Probabilistic Risk Assessments for Nuclear Power Plants*, NUREG/CR-2300, Vols. 1 and 2, U.S. Nuclear Regulatory Commission, 1983.
[63] *Guidelines for Chemical Process Quantitative Risk Analysis*, Center for Chemical Process Safety, AIChE, 1999. This guidance is out of print but scheduled for revision and reissue in summer 2000.
[64] *Reactor Safety Study: An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants*, WASH-1400, Atomic Energy Commission, 1975.

- Cremer and Warner, Ltd., "Assessment of Industrial Risks in the Rijnmond Area, Final Report," in *Risk Analysis of Six Potentially Hazardous Industrial Objects in the Rijnmond Area: A Pilot Study*[65]

- IEEE-STD-500, *IEEE Guide to the Collection and Presentation of Electrical, Electronic, and Sensing Component Reliability Data for Nuclear-Power Generating Stations*[66]

- AIChE *Guidelines for Process Equipment Reliability Data, with Data Tables*.[67]

Human reliability methods and data can be found in NUREG/CR-1278[68] and in IEEE Std 1023-1988.[69] Equipment reliability data in these references may or may not be applicable to the Contractor. These are not requirements documents for BNFL as identified in the SRD. The documents are cited as guides to the CAR reviewer for general techniques used in estimating equipment reliability rather than sources for contractor specific reliability data. If the Contractor uses in-house reliability data, then the method for selecting in-house data must be documented and the in-house reliability data must be applicable to this specific application of equipment.

5. **Considering Common-Cause and Common-Mode Failures –** This section is acceptable if the Contractor describes methods to ensure that common-cause/common-mode failures from the following events are considered. At a minimum, the following common-cause events should be addressed in identifying hazards: natural phenomena events (including earthquake), external man-made events, loss of electrical power, fire, internal missiles, and human error.

   Credible common-cause events should be treated as discrete events in the HA. The analysis of common-cause events shall focus on the identifying provisions to prevent the loss of safety function. Credible common-mode failures should be addressed using dependent failure modeling.

The Contractor should identify assumptions that may affect estimating either the frequency or consequences for each potential accident identified in the HAR. All important assumptions should be analyzed and uncertainties should be identified for (1) models and data used in calculating accident consequences and frequencies; (2) design, work descriptions and operational conditions; and (3) the range of consequence and frequency estimates.

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[65] Cremer and Warner, Ltd., "Assessment of Industrial Risks in the Rijnmond Area, Final Report," in *Risk Analysis of Six Potentially Hazardous Industrial Objects in the Rijnmond Area: A Pilot Study*, D. Reidel Publishing Company, 1982.
[66] *IEEE Guide to the Collection and Presentation of Electrical, Electronic, and Sensing Component Reliability Data for Nuclear-Power Generating Stations*, IEEE-STD-500, 1984.
[67] *Guidelines for Process Equipment Reliability Data, with Data Tables*, AIChE, Center for Chemical Process Safety, 1989.
[68] Swain, A. D., and H. E. Guttmann, *Handbook of Human Reliability Analysis with Emphasis on Nuclear Power Plant Applications*, NUREG-1278, U.S. Nuclear Regulatory Commission, 1983.
[69] *IEEE Guide for the Application of Human Factors Engineering to Systems, Equipment and Facilities of Nuclear Power Generating Stations*, IEEE Std 1023-1988, 1988.

To the extent that quantitative uncertainty information is unavailable, the control strategies selected should incorporate additional conservatism to ensure that safety criteria will be met with high confidence.

4.3.4 Review Procedures

The reviewer will determine whether the Contractor's information outlined in the acceptance criteria in Section 4.3.3 in this Guide has been provided and is sufficiently detailed so that the reviewer has an adequate understanding of the HA methods. Following the review, the reviewer will prepare input to the PSER, covering the material reviewed.

4.3.5 Evaluation Findings

The reviewer will prepare input for the PSER, stating whether the Contractor has provided all the information necessary to understand the HA methods. The report should include a summary statement of what was reviewed and why the reviewer finds the submittal acceptable. For example, the reviewer can document the review as follows:

> The HA methods have been reviewed against the acceptance criteria in Section 4.3.3 in this Guide and found to be acceptable. The reviewers conclude that the Contractor has adequately described the HA methods that will provide the information necessary to conduct thorough and accurate accident analyses to define DBEs and hazard control strategies. The information provided in the submittal is consistent with the current status of the facility and process design.

Any exceptions should be noted and stated in a way to provide the Contractor with a clear understanding of the revisions necessary to satisfy the RO. The reviewer may recommend to the RO that the submittal be conditionally approved with provisions for the Contractor to submit additional information within a specified timeframe.

4.4 HA RESULTS

4.4.1 Purpose of Review

The purpose of this review is to determine whether the Contractor's submittal adequately identifies hazards and potential accident/event sequences, estimates accident consequences and frequencies, and considers common-cause and common-mode failures.

4.4.2 Areas of Review

The reviewer will determine whether the Contractor's submittal accurately describes HA results for five areas. Appendix A of the SRD states that the hazard evaluation shall include results for each of the following five areas (these areas were described in Section 4.3 of this Guide):

1. **Identifying Hazards** – Hazards associated with the facility process, design, and operations are systematically identified.

2. **Identifying Potential Accident/Event Sequences** – Potential accidents are examined in a structured, systematic approach.

3. **Estimating Accident Consequences** – The consequences for postulated accidents are examined.

4. **Estimating Accident Frequencies** – Internal and external accident frequencies are estimated.

5. **Considering Common-Cause and Common-Mode Failures** – Credible common-cause events such as natural phenomena events, external man-made events, loss of electrical power, fire, internal missiles, and internal flooding are considered.

In addition, uncertainties in the analyses must be clearly described and analyzed. Related information for HA methods is discussed in Section 4.3 in this Guide.

4.4.3 Acceptance Criteria

4.4.3.1 Acceptability Review

The reviewer will determine whether the Contractor's submittal on HA results contains sufficient information to evaluate the submittal against the criteria in 4.4.3.3, "Regulatory Acceptance Criteria," and is therefore ready for detailed review. If significant deficiencies are identified in the submittal, the Contractor will be requested to submit additional information before the start of the detailed review.

4.4.3.2 Regulatory and Contractual Requirements

The requirements for HA results are found in the following two general contractual requirements that are from the Regulatory Process document and apply to all five areas of the HA results review:

- Approval Condition: "Construction Authorization will be issued upon determination by the Director of the Regulatory Unit that: The radiological, nuclear, and process hazards associated with facility operation, including those from postulated accidents, have been *adequately assessed* [emphasis added]…to establish a basis for safe operation and an unambiguous definition of the safe-operating envelope."[70]

- Submittal Requirement: "The PSAR shall contain…an analysis of radiological, nuclear, and process hazards for the design."[71]

[70] *DOE Regulatory Process for Radiological, Nuclear and Process Safety for TWRS Privatization Contractors*, (Regulatory Process), DOE/RL-96-0003, Rev. 1, Section 3.3.3, "Authorization for Construction," item 8, July 1998.
[71] Ibid., Section 4.3.2, "Contractor Input," item 8.

In addition, the following contractual requirements apply to individual areas (as noted) of the review:

1. **Estimating Accident Consequences –** The related contractual requirement is Safety Criterion 3.2-1, which states, "Acceptable risk analyses shall be applied during the design to delineate provisions for the prevention and mitigation, including emergency preparedness and response, of otherwise risk-dominant events."

2. **Estimating Accident Frequencies –** Safety Criterion 3.2-1, which states, "Acceptable risk analyses shall be applied during the design to delineate provisions for the prevention and mitigation, including emergency preparedness and response, of otherwise risk-dominant events" also applies because performance of risk analyses implies a requirement to estimate accident frequencies. Estimation of risk implies knowledge of accident frequency and consequence.

3. **Considering Common-Cause and Common-Mode Failures –** All of Section 4.5, "Consideration of Common Cause/Common Mode Failures," of Appendix A of the SRD is a contractual requirement.

In addition to these requirements, other requirements address uncertainty in data and analyses. The Contractor is required to provide "An analysis of the safety basis for the facility (safety envelope) in terms of … *uncertainties in data and analysis* [emphasis added]…"[72] Also, Safety Criterion 2.0-1, footnote (3) to Table 2.1, states, "In addition to meeting the listed exposure standards for accidents, BNFL's approach to accident mitigation is to evaluate accident consequences to ensure that the calculated exposures are far enough below *standards to account for uncertainties in the analysis*, [emphasis added] and to provide sufficient design margin and operational flexibility."

4.4.3.3 Regulatory Acceptance Criteria

The HA results submittal, including accident sequences, is acceptable if the criteria described below are met.[73] The Contractor may document the required information in two tables. One table would document the accident sequences and the second table would document the required information for the hazard evaluation. The accident sequence table may include information such as accident number, location, accident description, consequences, significant causes or energy sources, credited prevention, receptors, credited mitigation, accident frequency, and accident consequence. Typically, the information is arranged by accident sequence. The hazard evaluation table would contain similar categories organized by hazards, with less detailed information about particular accident sequences. The Contractor may use a risk matrix similar to that found in the AIChE *Guidelines for Hazard Evaluation Procedure*, Figure 7.1,[74] to assign hazard severity bin categories. At a minimum, the Contractor should provide the following information as a result of the HA:

[72] Ibid., item 15.
[73] Alternative descriptions also may be acceptable if they are adequately justified and meet applicable requirements.
[74] *Guidelines for Hazard Evaluation Procedures*, Second Edition with Worked Examples, Center for Chemical Process Safety, AIChe, 1992.

1. **Identifying Hazards –** This section is acceptable if the Contractor provides a complete list of hazards, potential consequences, possible causes, and estimated frequencies in a table. An example of a typical HAZOP table and the documentation is provided in Section 6.7, Table 6.16, and Section 14.3, Table 14.2, of the AIChE *Guidelines.*[75] The information provided in this section is also a necessary component of process safety information and should be cross-referenced in the submittal and coordinated with the review of "Process Safety Information," Section 4.1 in this Guide.

2. **Identifying Potential Accident/Event Sequences –** This section is acceptable if the Contractor summarizes the accident sequences identified in the HAR. The identified sequences must be detailed enough to provide an adequate basis for estimating the consequences and the frequency of each accident. The accident sequences selected for detailed consideration as potential design-basis accidents should result in consequences of at least severity levels 1, 2, or 3 as defined in Appendix A of the SRD. The Contractor should also combine into one accident scenario, accidents with common consequences to ensure that the risks of potential higher frequency events are properly evaluated. Numerical estimates are not required or expected for all accident sequences. The level of precision required is that necessary to ensure that the RES, chemical risk exposure standards, and safety objectives[76] are met, as well as the associated risk goals. Where reliable data are not available to support this determination, conservative application of defense in depth and engineering judgment to complete the estimate is expected. The Contractor may use tables to provide the necessary information such as accident number, location, accident description, consequences, significant causes or energy sources, credited prevention, receptors, credited mitigation, receptor, accident frequency, and accident consequence.

   The Contractor also should provide the following information: (1) the accident sequences that link initiating events with prevention and mitigation measures and other contributing phenomena, noting each response, action, or indication required to initiate action that is relevant to the accident sequence progression; (2) rationale for sorting hazardous situations into accident bins or categories (i.e., liquid spills and chemical reactions) and for selecting specific cases that will be analyzed in more detail; (3) the selection of accident sequences that are both comprehensive and credible; and (4) an evaluation of secondary events directly caused by external events (such as hazards from other facilities, aircraft crashes, pipeline ruptures, and truck crashes).

3. **Estimating Accident Consequences –** This section is acceptable if the Contractor provides a comprehensive estimation of accident sequence and consequences. This may be a qualitative assessment based on sound engineering judgment or a traceable reference to the quantitative evaluation.

   The Contractor should provide complete calculated accident consequences of accidents. For internal doses, the Contractor should ensure that the proper dose conversion factors

[75] Ibid., Section 6.7, "Typical Format for a What-If Analysis Worksheet," and Section 14.3, "Discussion of Results," AIChE, 1992.

[76] *Top-Level Radiological, Nuclear, and Process Safety Standards and Principles for TWRS Privatization Contractors* (Top-Level Standards), DOE/RL-96-0006, Rev. 1, Section 3.0, "Radiological and Nuclear Safety Objectives," July 1998.

have been used to calculate the total effective dose equivalent. Because the Contractor can use either quantitative or qualitative analysis methods for estimating the risk from accidents, but must use quantitative methods to document the risks for DBEs, the guidance for reviewing the quantitative calculations has been consolidated in Sections 4.5 and 4.6 in the CAR Guide. Appendix A in the SRD states in Section 4.3.2, "Accident Analysis," that the accident analysis shall consider inventory of material at risk; respirable release fraction; airborne material release fraction; bounding atmospheric dispersion coefficients, if appropriate; radiological composition of the material released; external radiation field; and exposure time.

The Contractor should also describe the potential consequences of releases of hazardous chemicals. The consequence estimates will address consequences to facility and co-located workers and the public. The Contractor has committed to take additional measures to mitigate or prevent releases of hazardous chemicals that could exceed ERPG-2 (or equivalent limits) for exposure to facility and co-located workers and the public. The Contractor should evaluate chemical consequences and determine which events could lead to ERPG-2 exposures or other levels of chemical exposure that could lead to similar consequences. The risk from chemical hazards should be managed as specified in the SRD. Guidance for quantitative assessments of chemical accidents and expected documentation can be found in the AIChE *Guidelines for Chemical Process Quantitative Risk Analysis*[77] and in *Guidelines for Consequence Analysis of Chemical Releases.*[78]

The Contractor should document the criteria that are used for binning or ranking the accident sequences. Criteria should be provided for assigning accidents to the consequence categories. If the Contractor is using qualitative criteria to bin consequences, then the criteria should provide the basis for qualitative binning.

4. **Estimating Accident Frequencies –** This section is acceptable if the Contractor provides an adequate technical basis to confirm its estimate of accident frequencies. The Contractor may estimate the frequency of accident initiators using engineering judgment or, if reliability data exist, more formal quantitative techniques such as fault or event trees. Criteria should be provided for assigning accidents to the frequency categories. If the Contractor is using qualitative criteria to bin accidents, then the criteria should provide the basis for qualitative or quantitative binning.

   This section is acceptable if an adequate basis provides confidence in either engineering judgment or more formal analytical techniques that may have been used. While quantitative estimates may be preferred, qualitative estimates of the accident frequencies are acceptable if the estimates are based on sound engineering judgment and the basis is provided. The engineering judgment should be based on conservative estimates that bound the results. The basis for the estimate should also include the reason why the qualitative estimate is conservative.

[77] *Guidelines for Chemical Process Quantitative Risk Analysis*, Center for Chemical Process Safety, AIChE, 1999. This guidance is out of print but scheduled for revision and reissue in summer 2000.
[78] *Guidelines for Consequence Analysis of Chemical Releases*, Center for Chemical Process Safety, AIChE, 1999.

If other analytical techniques (e.g., fault tree or event tree) are used, the source of quantitative input such as reliability data or experience, along with associated uncertainties, must be cited. Procedures and data for analytical techniques should be cited in the analysis.

Guidance for the assessment and documentation of accident frequencies can be found in the following documents:

- NUREG/CR-2300, *PRA Procedures Guide – A Guide to the Performance of Probabilistic Risk Assessments for Nuclear Power Plants*, Vols. 1 and 2[79]

- AIChE *Guidelines for Chemical Process Quantitative Risk Analysis*.[80]

Guidance on estimating equipment reliability data can be found in the following documents:

- WASH-1400, *Reactor Safety Study: An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants*[81]

- Cremer and Warner, Ltd., "Assessment of Industrial Risks in the Rijnmond Area, Final Report," in *Risk Analysis of Six Potentially Hazardous Industrial Objects in the Rijnmond Area: A Pilot Study*[82]

- IEEE-STD-500, *IEEE Guide to the Collection and Presentation of Electrical, Electronic, and Sensing Component Reliability Data for Nuclear-Power Generating Stations*[83]

- AIChE *Guidelines for Process Equipment Reliability Data, with Data Tables*.[84]

Human reliability methods and data can be found in NUREG/CR-1278[85] and in IEEE STD 1023-1988.[86] If the Contractor uses in-house reliability data, then the method for selecting in-house data must be documented. The in-house reliability data must be applicable to this specific application of equipment.

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[79] *PRA Procedures Guide – A Guide to the Performance of Probabilistic Risk Assessments for Nuclear Power Plants*, NUREG/CR-2300, Vols. 1 and 2, U.S. Nuclear Regulatory Commission, 1983/

[80] *Guidelines for Chemical Process Quantitative Risk Analysis*, Center for Chemical Process Safety, AIChE, 1999. This guidance is out of print but scheduled for revision and reissue in summer 2000.

[81] *Reactor Safety Study: An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants*, WASH-1400, Atomic Energy Commission, 1975.

[82] Cremer and Warner, Ltd., "Assessment of Industrial Risks in the Rijnmond Area, Final Report," in *Risk Analysis of Six Potentially Hazardous Industrial Objects in the Rijnmond Area: A Pilot Study*, D. Reidel Publishing Company, 1982.

[83] *IEEE Guide to the Collection and Presentation of Electrical, Electronic, and Sensing Component Reliability Data for Nuclear-Power Generating Stations*, IEEE-STD-500, 1984.

[84] *Guidelines for Process Equipment Reliability Data, with Data Tables*, Center for Chemical Process Safety, AIChE, 1989.

[85] Swain, A.D., and H.E. Guttman, *Handbook of Human Reliability Analysis with Emphasis on Nuclear Power Plant Applications*, NUREG/CR-1278, U.S. Nuclear Regulatory Commission, 1983.

[86] *IEEE Guide for the Application of Human Factors Engineering to Systems, Equipment and Facilities of Nuclear Power Generating Stations*, IEEE STD 1023, 1988.

5. **Considering Common-Cause and Common-Mode Failures –** This section is acceptable if the Contractor adequately evaluates potential system interactions with significant consequences. Section 4.5, "Consideration of Common Cause/Common Mode Failures," in Appendix A of the SRD[87] requires that the hazard evaluation shall consider common-cause (e.g., natural phenomena events, external man-made events, loss of electrical power, fire, internal missiles, and flooding) and credible common-mode failures. The Contractor should describe the following:

   - Credible common-cause events that are treated as discrete events in the HA (see Section 4.5 "Consideration of Common Cause/Common Mode Failures" in Appendix A of the SRD).

   - The potential for human error, particularly in maintenance activities, to cause common-mode failures.

   - External events that can initiate common-mode failures. These are discussed in more detail in Section 4.6, "External Design-Basis Accidents" in this Guide.

   - The treatment of common-mode failures through dependent failure modeling, as required in Section 4.4, "Estimation of Accident Frequencies," of Appendix A in the SRD.

   In addition to the above specific regulatory acceptance criteria, the Contractor should document uncertainties and address the following:

   - All significant uncertainties in models (including input assumptions, boundary conditions and modeling techniques), data, and phenomenology used in estimating accident consequences and frequencies.

   - Delineation of all major uncertainties in design, work descriptions, and operational conditions.

4.4.4 Review Procedures

The reviewer will determine whether the Contractor's information outlined in the acceptance criteria in Section 4.4.3 in this Guide has been provided and is sufficiently detailed so that the reviewer has an adequate understanding of HA results. Following the review, the reviewer will prepare input to the PSER, covering the material reviewed.

4.4.5 Evaluation Findings

The reviewer will prepare input for the PSER, stating whether the Contractor has provided all the information necessary to understand the HA results. The report should include a summary

[87] *Safety Requirements Document*, BNFL-5193-SRD-01, Rev. 2, Appendix A, "Implementing Standard for Safety Standards and Requirements Identification," Section 4.5, "Consideration of Common Cause/Common Mode Failures," December 1998.

statement of what was reviewed and why the reviewer finds the submittal acceptable. For example, the reviewer can document the review as follows:

> The HA results section has been reviewed against the acceptance criteria in Section 4.4.3 in this Guide and found acceptable. The reviewers conclude that the information is consistent with the current status of the facility and process design.

Any exceptions should be noted and stated in a way to provide the Contractor with a clear understanding of the revisions necessary to satisfy the RO. The reviewer may recommend to the RO that the submittal be conditionally approved with provisions for the Contractor to submit additional information within a specified timeframe.

5.0 QAPIP

The Contractor's most recent QAPIP will have been reviewed immediately prior to the submittal of the SA Package for the CAR. An evaluation report for this review will be issued separately. Additional review of the Contractor's quality assurance program will be performed during the CAR review, using Section 3.3 of the CAR Review Guidance.[88] For the SA Package review, the reviewer should check for consistency between the ISMP and the most recently approved QAPIP.[89]

6.0 LIST OF TERMS

ABAR	Authorization Basis Amendment Request
AIChE	American Institute of Chemical Engineers
BNFL	BNFL Inc.
CAR	Construction Authorization Request
DBE	design basis event
DOE	U.S. Department of Energy
ERPG	Emergency Response Planning Guide
HA	Hazard Analysis
HAR	Hazard Analysis Report
HAZOP	Hazard and operability analysis
ISAR	Initial Safety Analysis Report
ISMP	Integrated Safety Management Plan
ISRT	Independent Safety Review Team
PRA	Probabilistic Risk Assessment
PSA	Preliminary Safety Analysis
PSAR	Preliminary Safety Analysis Report
PSC	Project Safety Committee
PSER	Preliminary Safety Evaluation Report
QAPIP	Quality Assurance Program and Implementation Plan

[88] *Review Guidance for the Construction Authorization Request (CAR)*, RL/REG-99-05, Rev. 2, January 2000.
[89] *DOE Regulatory Unit Evaluation Report of BNFL Inc.'s Quality Assurance Program and Implementation Plan*, Rev. 0, January 7, 2000, requires a revision to ISMP, Rev. 4. This revision should have been addressed by an ABAR before the SAP has been submitted for construction authorization.

RES	Radiological Exposure Standards
RL	Richland Operations Office
RO	Regulatory Official
RU	Regulatory Unit
SA Package	Standards Approval Package
SRD	Safety Requirements Document
SSC	structures, systems, and components
TWRS-P	Tank Waste Remediation System-Privatization